VIII-2. Evaluation of Characteristics of Citrus Genetic Resources

Ten to twelve mature leaves, flowers and mature fruits per tree are measured with 3 replications.

1. Primary characters

<Essential items>

Vegetative life cycle

This character is classified into 3: evergreen, 5: semi-deciduous, 7: deciduous.

Density of twigs

Density of twigs is classified by observation into 3: low, 5: intermediate, 7: high.

Length of spine

Length of spine in the central part of one-year-old shoots is measured and classified into 1: no spines, 3: short (<10 mm), 5: medium (10 ~ 19 mm), 7: long (≥20 mm).

Type of leaf

Type of leaf is classified into 3: simple, 5: trifoliate, 7: both simple and trifoliate.

Shape of leaf blade

Shape of leaf blade is classified into 1: ovate , 3: elliptical, 5: obovate, 7: lanceolate, 9: orbicular. (Fig. 1)

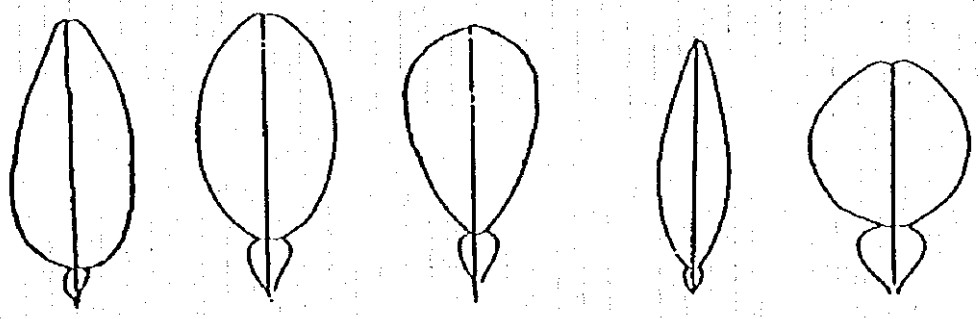

Fig. 1 Shape of leaf blade.

Length of leaf blade

Length from the base to the top of the leaf blade is measured (in mm).

Width of leaf blade

Width of leaf blade in the widest area is measured (in mm).

Length of petiole (mm)

Shape of petiole wings

Shape of petiole wings is classified into 1: cordate, 3: wedge-shaped, 5: spindle-shaped, 7: vestigial, 9: absent. (Fig. 2)

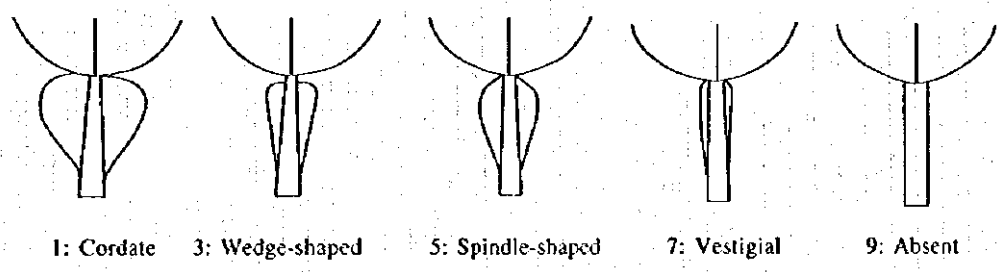

Fig. 2 Shape of petiole wings.

Arrangement of flowers

Presence of inflorescences is observed at flowering time. This character is classified into 3: solitary, 5: in an inflorescence, 7: both solitary and in an inflorescence.

Color of petals

Color of outer surface of petals is observed and classified into 3: white, 5: light yellow, 7: purple.

Fruit shape

Fruit shape is classified into 1: depressed, 3: oblate, 5: globose, 7: ellipsoid, 9: pyriform. (Fig. 3)

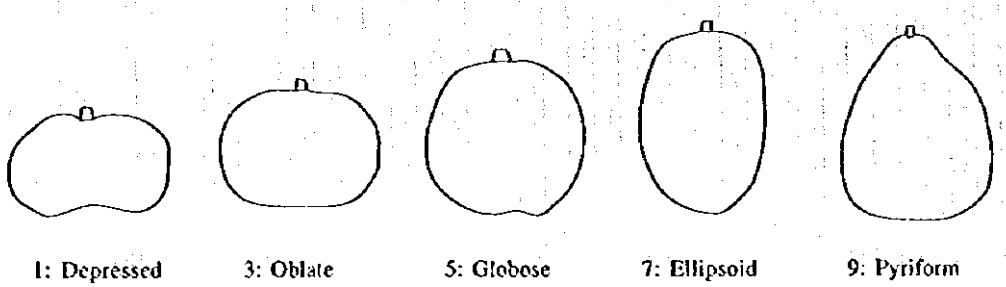

Fig. 3. Fruit shape.

Shape of base of fruit

Shape of base of fruit is classified into 1: long-necked, 2: short-necked, 3: evenly rounded, 4: flat or truncate, 5: moderately depressed, 6: deeply depressed, 7: low-collared and depressed, 8: high-collared and depressed, 9: low-collared and short necked. (Fig. 4)

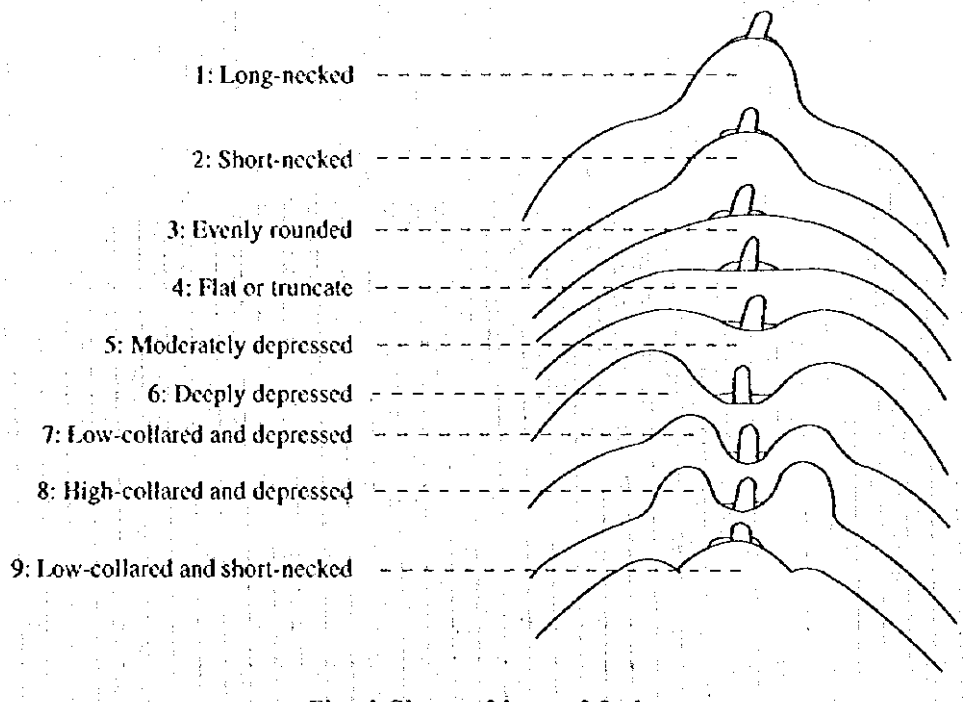

Fig. 4 Shape of base of fruit.

Shape of apex of fruit

Shape of apex of fruit is classified into 1: protruding, 3: truncate, 5: depressed, 7: rounded. (Fig. 5)

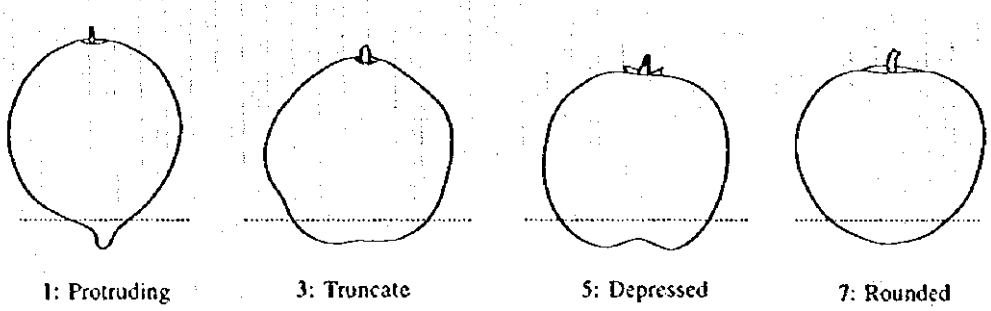

Fig. 5 Shape of apex of fruit.

Peeling

Peel fruit by hand and classify degree of ease of peeling into 1: easy, 3: easy-moderate, 5: moderate, 7: moderate-difficult, 9: difficult.

Color of peel

Color of peel of mature fruit is classified into 1: green, 2: yellow-green, 3: yellowish white; 4: yellow, 5: yellowish orange, 6: orange, 7: deep orange, 8: reddish.

Color of pulp

Cut mature fruit in half and observe the color of pulp in a cross section. This character is classified into 1: light green, 2: cream, 3: yellow, 4: yellowish orange, 5: orange, 6: deep orange, 7: pink, 8: red-purple.

<Optional items>

Color of shoot tip

Color of shoot tip is observed when shoots are 2 cm long and classified into 1: light yellow, 3: light green 5: green, 7: purple, 9: deep purple.

Number of petals

Length of petal (mm)

Width of petal

Width of petal in the widest area is measured (in mm).

Areole at apex of fruit

Areole at apex of fruit is classified into 3: absent, 5: not conspicuous, 7: prominent.

Navel at apex of fruit

Navel at apex of fruit is classified into 1: absent, 2: present.

Color of albedo

Color of albedo of mature fruit is classified into 1: white, 3: cream, 5: light yellow, 7: light orange, 9: reddish.

Seed color

Color of fresh and mature seeds is observed through seed coat and classified into 1: white, 3: cream, 5: yellowish, 7: green, 9: brown.

Cotyledon color

Cotyledon color of mature seeds of polyembryonic species and cultivars is examined. That of monoembryonic species and cultivars is influenced by pollen parents and segregates. This

character is classified into 1: white, 3: cream, 5: light green, 7: green, 9: deep green.

2. Secondary characters

<Essential items>

Vigor of tree

Vigor of tree is classified into 3: low, 5: intermediate, 7: high.

Shape of tree

Shape of tree is classified into 3: ellipsoid, 5: spheroid, 7: oblate.

Habit of tree

Direction of twigs is observed and classified into 3: upright, 5: spreading, 7: weeping.

Flowering time

The time when the tree is at the full bloom stage is observed and classified into 1: early, 3: midseason, 5: late, 7: others (ex. kumquat, trifoliate orange).

Secondary flowering

Observe secondary flowering and classify into 1: absent , 2: present.

Season of fruit maturity

Season of fruit maturity is classified into 1: very early, 3: early, 5: midseason, 7: late, 9: very late.

Weight of fruit (g)

Surface of peel

Surface of peel at maturity is observed and classified into 3: coarse, 5: intermediate, 7: smooth.

Thickness of peel

Cut mature fruit in half and measure thickness of peel (in mm).

Number of segments per fruit

Adherence of segments to each other

This character is classified into 3: slight, 5: moderate, 7: strong.

Thickness of segment membrane

Thickness of segment membrane of mature fruit is classified into 3: thin, 5: medium, 7: thick.

Number of seeds per fruit

Count the number of seeds except imperfect ones.

Length of seeds (mm)

Width of seeds (mm)

<RESISTANCE TO PEST AND DISEASES>

Resistance to adverse conditions, which are serious in the area, is evaluated under natural conditions or by artificial inoculation and classified into 1: extremely low, 3: low, 5: intermediate, 7: high, 9: extremely high.

Resistance to fungi and bacterial diseases

Resistance to virus and viroid diseases

Resistance to pests

<Optional Items>

Number of stamens per flower

Pollen fertility

Microscopic observation of pollen fertility is carried out by staining with acetocarmine for three flowers per plant, and examining 500 pollen grains per flower. The results are expressed in percentage.

Size of vesicles

Size of vesicles in the central part of the segments is observed and classified into 3: small, 5: medium, 7: large.

Shape of vesicles

Shape of vesicles in the central part of the segments is observed and classified into 3: slender, 5: intermediate, 7: stout.

Cold hardiness of tree

Cold hardiness of tree is evaluated by observing the damage of leaves, twigs and branches under natural and/or artificial conditions, and classified into 3: low, 5: intermediate, 7: high. The conditions should be clearly specified.

3. Tertiary characters

<Essential Items>

Aroma of peel

Aroma of peel is determined based on sensory test and classified into 3: weak, 5: intermediate, 7: strong.

Texture of pulp

Texture of pulp of mature fruit is determined based on sensory test and classified into 3: tender, 5: intermediate, 7: firm.

Bitterness of pulp

Degree of bitterness of pulp is determined based on sensory test and classified into 1: no bitterness, 3: low, 5: moderate, 7: high.

Juiciness of pulp

Juiciness of pulp of mature fruit is determined based on sensory test or by squeezing fruit using juicer and classified into 3: low, 5: moderate, 7: high.

Taste of juice

Taste of juice is determined based on sensory test and classified into 1: excellent, 3: good, 5: intermediate, 7: poor, 9: very poor.

Aroma of juice

Aroma of juice is determined based on sensory test and classified into 3: weak, 5: moderate, 7: strong.

Sugar content

Brix value of filtrate of juice squeezed from mature fruits is measured with a refractometer.

Titratable acidity

Titratable acidity is measured by titrating filtrate of juice squeezed from mature fruits. The acidity is expressed in % of citric acid.

Puffing of peel

Degree of puffing of peel at maturity is classified into 1: no puffing, 3: low, 5: intermediate, 7: high.

Granulations of pulp

Degree of granulation of pulp is classified by observing the cross section of fruit into 1: no granulations, 3: low, 4: intermediate, 7: high.

Fruit cracking

Degree of occurrence of fruit cracking is classified into 1: no cracking, 3: low, 5: intermediate, 7: high.

Dessert fruit quality

This character is classified into 1: poor, 3: fair, 5: good, 7: excellent.

Shipping quality

This character is classified into 1: poor, 3: fair, 5: good, 7: excellent.

<Optional items>

Condition of oil glands of peel

Condition of oil glands is classified into 3: depressed, 5: even, 7: convex.

Size of oil glands on fruit surface

Diameter of ten oil glands per fruit, except minute ones, in the equatorial area of fruit is measured and classified into 3: small (<0.8 mm), 5: intermediate (0.8~1.1 mm), 7: large (≥1.2 mm).

Density of oil glands on fruit surface

Number of oil glands per square centimeter in the equatorial area of fruit is counted. Minute oil glands are omitted. The density is classified into 3: low (<40), 5: intermediate (40~69), 7: high (≥70).

Central axis of fruit

State of central axis is determined at maturity by observing cross section of fruit and classified into 3: hollow, 5: semi-hollow, 7: solid.

Size of central axis of fruit

Diameter of central axis in median cross section is measured (mm).

Color of chalazal spot

After removing the outer seed coat, chalazal spot is observed and classified into 1: white, 2: ivory, 3: cream, 4: yellow, 5: beige, 6: brown, 7: reddish, 8: purple.

Number of embryos per seed

After removing the seed coats, number of embryos is counted for 30 seeds using a stereoscopic microscope.

Reference

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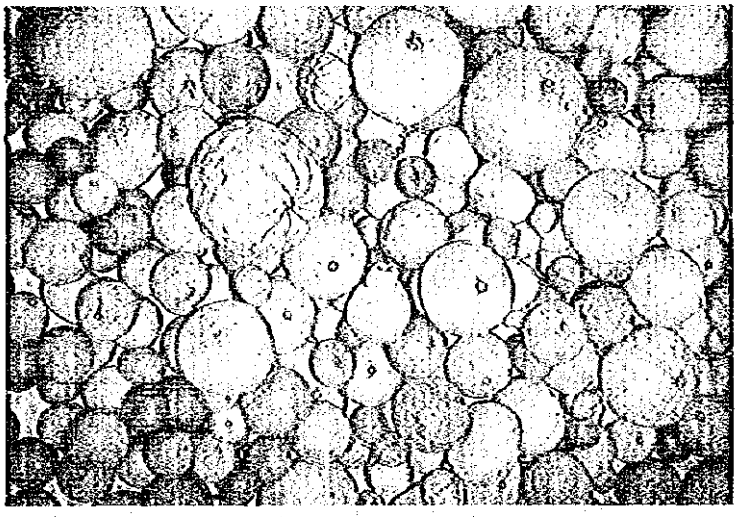

Photo. 1 Variation of shape and size of citrus fruits.

Photo. 2 Graft operation in a nursery.

IX. Loquat

IX-1. Cultivation of Loquat Genetic Resources for Evaluation of Characteristics

IX-2. Evaluation of Characteristics of Loquat Genetic Resources

by

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IX-1. Cultivation of Loquat Genetic Resources for Evaluation of Characteristics

1. General properties

Loquat (*Eriobotrya*), a member of the Rosaceae family, which consists of about 20 species, is considered to have originated in the southern temperate and subtropical zone of eastern Asia. *E. japonica* is the most popular species that usually matures from mid-May to mid-June in Japan.

Loquat cultivation is recommended for areas where the minimum temperatures during flowering and young fruit growth (December to March) are above -3°C. Recently, in Japan, loquats have been grown under plastic film supported by stakes.

2. Propagation

Raising of rootstocks

The most popular rootstocks for loquat are seedlings of *E. japonica* (common loquat). Seeds are collected from mature fruits and washed with tap water. Then, seeds are sown at a spacing of 6 ~ 10cm between seeds and 3 ~ 5cm in depth, in seed boxes filled with a mixture of peat-moss and Kanuma-soil. Seed boxes are put in a greenhouse with shading. Seeds germinate from late July to early August and seedlings are transplanted into unglazed pots 20cm in diameter filled with a mixture of peat-moss and Kanuma-soil, and kept in the greenhouse.

Preparation of scions

Before grafting, it is necessary to prepare scions cut from the trees known to be true-to-type. Disease-free shoots with healthy vegetative buds which appeared in the previous summer are selected for scions. Scions used for veneer-grafting are 6 ~ 10cm in length with 3 ~ 4 buds.

Grafting

Veneer-grafting is most commonly practiced for the propagation of loquat trees. Scions are usually grafted to 2 years old seedlings in spring prior to active sap flow. Around one month after grafting, scions begin budding out. Bud-grafting and topworking are also carried out for the propagation of scion cultivars. Bud-grafting is carried out from March to April or late August to early September.

Management of nursery

Grafted nursery plants are grown in pots or nursery fields during a period of 1 to 2 years. They are supported by poles to protect graft unions from the wind. Weed control, irrigation and cutting of suckers are important procedures for healthy growth of nursery plants. Grafting tapes are removed before cutting into graft unions.

3. Planting (Transplanting)

Transplanting is carried out from late winter to early spring. Well-fermented farmyard manure is applied in planting holes about 60 x 60 cm in depth and width before planting.

Standard planting distance (5 ~ 7 m) varies depending upon the tree vigor of the particular cultivar or soil types of orchards. After planting, nursery plants are supported by poles to protect from wind damage, and are irrigated to put soil into the root systems.

4. Preparation of cultivation field (Site selection and orchard design)

As already described, loquats are grown only in areas with a mild climate where the average yearly temperatures are above around 15°C and temperatures below -3°C do not continue for more than several hours during the period from winter to spring, since flowers and young fruits are sensitive to low temperatures. In windy areas, loquat trees must be protected by windbreaks since they have shallow root systems. Soil with a pH of about 6.0 and with good drainage is suitable for loquat cultivation.

5. Training and pruning of trees

Loquat trees are trained into an open-center system. To allow sunshine penetration into tree crowns and to promote fruit setting, branches are pulled down by ropes.

Pruning is carried out in September when flower buds become visible. From overgrown parts of tree crowns, branches are removed with scissors or handsaws. Then, sprouts are removed or cut back. Since the Japanese market requires large fruit size, it is necessary to reduce the number of bearing shoots on branches which appeared in the preceding year.

6. Thinning of flowers and fruitlets

Poor flower clusters are removed from trees with overproducted flower clusters from mid- to late October. Lateral peduncles are removed from the upper and bottom parts of the remaining flower clusters.

Fruit thinning is carried out in late March. Three healthy fruits per fruit cluster are maintained, and are covered by paper bags.

7. Soil management

Sod culture system is usually applied for loquat cultivation. In this system, orchards are mowed 2 to 3 times in a year. To protect soil from drying and erosion, mowed grasses are spread under the loquat trees.

8. Fertilization

Nitrogen, phosphorus and potassium are applied three times in a year (mid-February, early to mid-June and late August to early September) as basal fertilizer under tree crowns. Amount of fertilizer depends on the age of the tree, cultivar and soil type. The standard rates of nitrogen, phosphorus and potassium application are 170kg/ha, 115kg/ha and 125kg/ha, respectively for 10 years old trees of cultivar 'Mogi'. Half of the nitrogen and potassium is applied from late August to early September. To alleviate magnesium deficiency, micronutrients are applied.

9. Control of pests and diseases

Pear green aphid (*Nippolachnus piri*), Oriental fruit moth (*Grapholitha molesta*), peach curculio (*Rhynchites heros*) and mulberry borer (*Apriona japonica*) are serious pests. For controlling pear green aphid, pesticides are usually sprayed two times in a year (spring and autumn) on plants.

Serious diseases, which cause economic damage to loquats, are canker (*Pseudomonas syringae* pv. *eriobotryae*), gray leaf spot (*Pestalotia funerea*), leaf spot (*Phyllostica eriobotryae*) and white root rot (*Rosellinia necatrix*). Canker, which is the most serious disease for many loquat cultivars, infects through wounds. For controlling this disease, therefore, it is necessary to spray fungicides after pruning, thinning, disbudding and after the fruiting stage.

10. Harvest

Loquat cultivars are classified into two types by the skin color of fruit: orange-yellow and yellowish white. Change of skin color to the original ripe color is a useful indicator for optimum harvest time. However, in case of yellowish white cultivars, determination of the ripe color is rather difficult.

Since loquat fruits are easily injured, fruits should be handled carefully.

11. Storage

Loquat fruits are not stored usually, since their storage ability is low.

IX-2. Evaluation of Characteristics of Loquat Genetic Resources

1. Primary characters

<Essential items>

Tree habit

Tree habit is observed during the dormancy period of shoot elongation for two trees, and classified into 3: upright, 5: intermediate, 7: spreading.

Tree vigor

Tree vigor is determined during the dormancy period of shoot elongation for two trees, and classified into 3: low, 5: intermediate, 7: high.

Density of shoots

Density of shoots is determined based on the number of shoots per tree crown during the dormancy period of shoot elongation for two trees, and classified into 3: low, 5: intermediate, 7: high.

Amount of pubescence on young leaf

Amount of pubescence on young leaf is determined based on the density of pubescence on young leaf for ten shoots which are in the early stage of elongation, and classified into 3: scarce, 5: intermediate, 7: abundant.

Shape of leaf blade

Shape of leaf blade is determined based on the width/length ratio for 15 fully developed leaves which appeared in the middle part of the central shoots during winter time, and classified into 3: narrow (width/length $\leq$ 0.30), 5: intermediate (0.31 ~ 0.35), 7: broad ($\geq$ 0.36).

Shape of flower cluster

Shape of flower cluster is observed for ten clusters on normal central shoots during the early flowering season, and classified into 3: conical, 5: intermediate, 7: cylindric.

Flower size

Flower size is observed for flowers of ten clusters on moderately growing central shoots at full bloom, and classified into 3: small, 5: intermediate, 7: large.

Petal color

Petal color is observed for flowers of ten clusters borne on normal central shoots at full bloom, and classified into 3: white, 5: yellowish white, 7: yellow.

Fruit shape in longitudinal section

Fruit shape in longitudinal section is observed for 20 typical fruits at harvest, and classified into 1: oblate, 2: round, 3: obovate, 4: round elliptical, 5: long obovate, 6: elliptical (Fig.1).

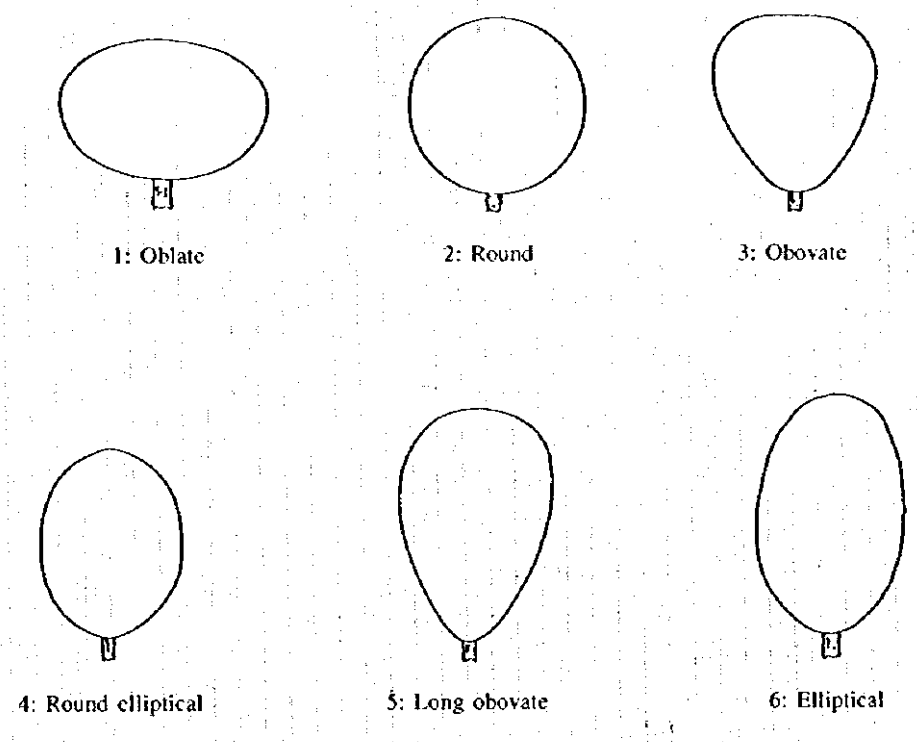

Fig.1 Fruit shape in longitudinal section.

Color of fruit skin

Color of fruit skin is observed for 20 typical fruits based on examination or comparison with the color chart of R.H.S. at harvest, and classified into 1: white, 3: yellowish white, 5: yellow, 7: orange-yellow, 9: orange.

Color of fruit flesh

Color of fruit flesh is observed for 20 typical fruits at harvest, and classified into 1: white, 3: yellowish white, 5: yellow, 7: orange-yellow, 9: orange.

<Optional items>

Shape of leaf blade in cross section

Shape of leaf blade in cross section is observed for 20 fully developed leaves in the middle

part of central shoots in winter, and classified into 3: inflected, 5: plane, 7: recurved.

Luster of leaf blade

Luster of leaf blade is observed for 20 fully developed leaves in the middle part of central shoots in winter, and classified into 0: absent, 9: present.

Seed shape in longitudinal section

Seed shape in longitudinal section is observed for seeds of 20 typical fruits at harvest, and classified into 1: round, 2: obovate, 3: round elliptical, 4: long obovate, 5: elliptical (Fig.2).

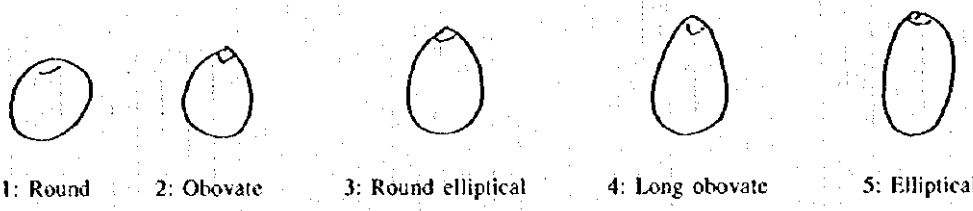

Fig.2 Seed shape in longitudinal section.

Number of small spots on seed surface

The number of small spots on the seed surface is observed for seeds of 20 typical fruits at harvest, and classified into 0: absent, 3: a few, 7: many.

2. Secondary characters

<Essential items>

Time of flower budding

Time of flower budding is determined based on the date when flower buds become apparent on 10% of central normal shoots, and classified into 3: early, 5: intermediate, 7: late.

Flowering time

Flowering time is determined based on the date when 50% of flower buds bloomed on central normal shoots, and classified into 3: early, 5: intermediate, 7: late.

Bearing of central shoots

Bearing of central shoots is determined based on the number of bearing shoots per 50 central shoots, and classified into 3: a few, 5: intermediate, 7: many.

Bearing of lateral shoots

Bearing of lateral shoots is determined based on the number of bearing shoots per 50 lateral shoots, and classified into 3: a few, 5: intermediate, 7: many.

Number of flowers in flower cluster

The number of flowers per cluster is counted for 20 flower clusters borne on normal central shoots at early bloom, and classified into 3: a few (≤80 flowers / flower cluster), 5: intermediate (81 ~ 120), 7: many (≥121).

Maturation period

Maturation period is determined based on the date when the largest number of fruits is harvested, and classified into 1: very early, 3: early, 5: intermediate, 7: late, 9: very late.

Fruit size

Fruit size is calculated based on the average weight of fruits which is measured for 20 fruits borne on more than five clusters of normal central shoots, and classified into 1: very small (≤20.0g), 3: small (20.1 ~ 40.0g), 5: intermediate (40.1 ~ 60.0g), 7: large (60.1 ~ 100.0g), 9: very large (≥100.1g).

Shape of fruit apex

Shape of fruit apex is observed for 20 typical fruits, and classified into 3: concave, 5: flat, 7: convex.

Calyx cavity of fruit

Calyx cavity of fruit is observed for 20 typical fruits, and classified into 3: closed, 5: slightly open, 7: open.

Cold tolerance

Cold tolerance of young fruits is determined based on the survival rate of young fruits borne on 10 flower clusters exposed to low temperature. Survival of fruits is confirmed after cutting them. Cold tolerance is classified into 3: low, 5: intermediate, 7: high.

<Optional Items>

Duration of flowering

Duration of flowering is determined based on the period from 5-10% flowering to 90% flowering, and classified into 3: short, 5: intermediate, 7: long.

Uniformity of fruit size

Uniformity of fruit size is observed for 15 fruits borne on five clusters at harvest, and classified into 3: low, 5: intermediate, 7: high.

Resistance to canker

Resistance to canker is determined based on natural infection or artificial inoculation, and classified into 3: low, 5: intermediate, 7: high.

3. Tertiary characters

<Essential items>

Proportion of flesh

Proportion of flesh is calculated based on the percentage of flesh weight to fruit weight for 20 typical fruits at harvest, and classified into 3: low (≤60.0%), 5: intermediate (60.1 ~ 70.0%), 7: high (≥70.1%).

Ease of fruit peeling

Ease of fruit peeling is determined by peeling of 20 typical fruits by hand from stalk end at harvest, and classified into 3: easy, 5: intermediate, 7: difficult.

Number of seeds

The average number of seeds per fruit is counted for seeds from 20 fruits at harvest, and classified into 3: few (≤3.0), 5: intermediate (3.1 ~ 5.0), 7: many (≥5.1).

Seed weight

Seed weight is measured for seeds of 20 fruits at harvest, and classified into 3: light (≤2.50g), 5: intermediate (2.51 ~ 3.00g), 7: heavy (≥3.01g).

Thickness of flesh

Thickness of flesh at the equator of fruits is measured for 20 typical fruits, and classified into 3: thin (≤7.0mm), 5: intermediate (7.1 ~ 10.0mm), 7: thick (≥10.1mm).

Firmness of flesh

Firmness of flesh is determined based on sensory test for 20 normally ripe fruits, and classified into 3: soft, 5: intermediate, 7: firm.

Brix value of juice

Brix value of juice is measured with a refractometer for 20 typical fruits at harvest, and classified into 3: low (≤12.0), 5: intermediate (12.1 ~ 14.0), 7: high (≥14.1).

Acidity of juice

Acidity of juice is measured by neutralization titration for 20 typical fruits at harvest, expressed in % of malic acid and classified into 3: low, (≤0.30%), 5: intermediate (0.31 ~ 0.50%), 7: high (≥0.51%).

Eating quality of fruit

Eating quality of fruit is evaluated based on sensory test for 20 normally ripe fruits, and classified into 3: low, 5: intermediate, 7: high.

Yielding ability

Yielding ability of fruit is determined based on the annual average yield per tree for four years, and classified into 3: low, 5: intermediate, 7: high.

Dark purple spots on fruit surface

Dark purple spots on fruit surface are observed for all the fruits from two trees at harvest, and classified into 0: absent, 3: a few, 5: intermediate, 7: many.

Green spots on fruit surface

Green spots on fruit surface are observed for all the fruits from two trees at harvest, and classified into 0: absent, 3: few, 5: intermediate, 7: many.

Freckles on fruit surface

Freckles on fruit surface are observed for all the fruits from two trees at harvest, and classified into 0: absent, 3: a few, 5: intermediate, 7: many.

<Optional items>

Flesh texture

Flesh texture is determined based on sensory test for 20 normally ripe fruits, and classified into 3: small, 5: intermediate, 7: large.

Amount of juice

Amount of juice is determined based on sensory test for 20 normally ripe fruits, and classified into 3: small, 5: intermediate, 7: large.

Flavor of fruit

Flavor of fruit is determined based on sensory test for 20 normally ripe fruits, and classified into 0: absent, 3: weak, 7: strong.

Browning of calyx

Browning of calyx is observed for all the fruits from two trees at harvest, and classified into 0: absent, 3: minimal, 5: intermediate, 7: extensive.

Fruit cracking

Fruit cracking is determined for all the fruits from two trees at harvest, and classified into 0: absent, 3: minimal, 5: intermediate, 7: extensive.

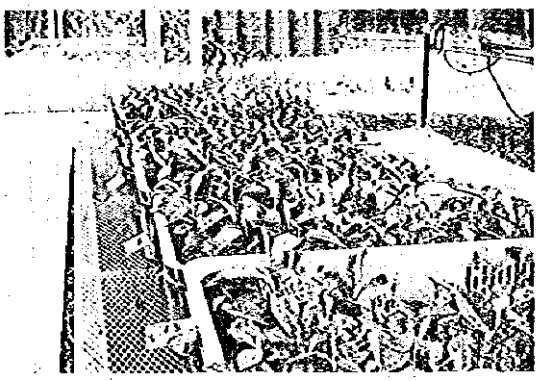

Photo. 1 Loquat seedlings raised in seedling boxes.

Photo. 2 Veneer-grafting of loquat.

Photo. 3 Flower cluster of loquat.

X. Pineapple

X-1. Cultivation of Pineapple Genetic Resources for Evaluation of Characteristics

X-2. Evaluation of Characteristics of Pineapple Genetic Resources

by

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X-1. Cultivation of Pineapple Genetic Resources for Evaluation of Characteristics

1. Crop cycles

A crop cycle from planting to the next crop extends over a period of five years. This five-year cycle includes the second ratoon crop, which is harvested just one year after the first harvest.

2. Soil preparation

Soil preparation normally starts several months before the planting time. In the first step of preparation, organic matter is applied. Old pineapple plants are crushed and chopped with a tractor-drawn multiple-disc chopper and scattered over the soil surface, then the fields are plowed several times. After the final plowing, fertilizer is applied and paper mulches with holes are set up.

3. Planting

Pineapple is planted in spring or summer. Planting materials consist of slips, hapas, crowns and shoots collected from the harvested plants are inserted by hand into the ground through holes of paper mulch, using flat, spatula-shaped iron tools. The planting density is 4,000 plants/10a (Fig. 1).

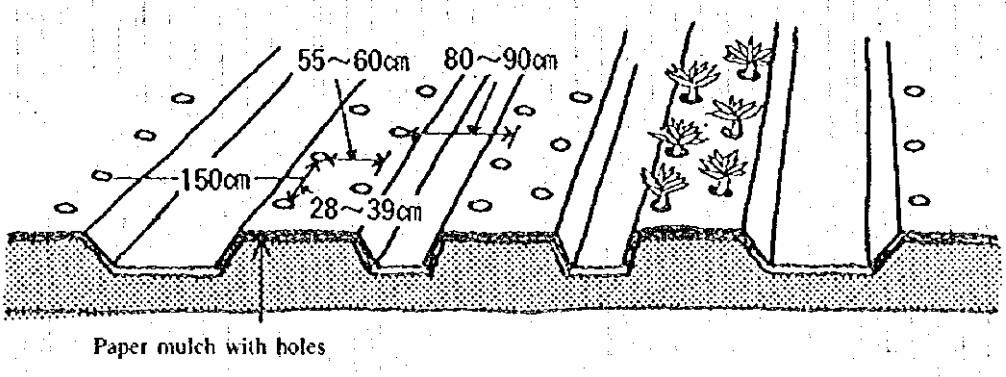

Fig. 1 Planting of pineapples.

4. Fertilizer application

Fertilizer (N:P:K=12:6:12) is applied at intervals during growth. The amount of fertilizer for basal application for summer planting is 120 kg per 10a. In the following year, 80 kg are applied in March and June, and 120 kg are applied in September.

5. Plant hormone

Acetylene gas in carbide solution causes flowering of pineapple plants, and by pouring a carbide solution into the hearts of plants, fruits are induced. As a result, ripe fruits are harvested off season, when consumers's demand and price are high. Harvest under natural conditions from summer to winter and harvest by hormone application in spring enable to secure a constant supply of fresh ripe fruits throughout the year.

6. Harvest

Pineapples are harvested one and half or two years after planting. Under natural conditions eighty percent of the fruits are harvested in summer, and twenty percent in winter. Harvest of natural summer fruits takes place mainly in August, while harvest of winter fruits is prolonged. Quality of summer fruits is good, unlike that of winter fruits. Harvest in autumn is possible after treatment with ethylene gas (ethrel) before the harvest of winter fruits. Spring fruits can be harvested after treatment with acetylene gas in a carbide solution before the harvest of summer fruits.

7. Disease control

Mealy-bug wilt

Mealy-bug wilt is one of the most widely distributed diseases and the most serious disease of pineapple. Control of mealy-bug is essential for the control of this disease. Application of organic phosphates is effective for practical control.

Marbled fruit

Marbled fruit is characterized by speckled browning and abnormal hardening of internal tissues without conspicuous symptoms on the fruit surface. Bacteria carried by insects are considered to be introduced into the stigma fluid or into nectars of open blossoms. Effective control of this disease is difficult by spray or dusting of bactericides. Application of cultural methods is the only effective method for reducing the susceptibility of Cayenne fruits.

Fruitlet core rot

Many kinds of microorganisms penetrate into the small tubes from the bottom of the blossom cup. During the development of fruits, most of them remain dormant, but they become active in the ripening period, and induce a discoloration of the duct walls and rot of fruitlet cores. These symptoms are frequently observed in winter fruits, while seldom in summer fruits. This disease is prevalent, especially in humid areas. Although most of the causal organisms have been identified, effective control measures for the prevention of this fruit-rot damage have not yet been developed.

X-2. Evaluation of Characteristics of Pineapple Genetic Resources

For the evaluation of the plant characteristics, 10 to 20 plants must be observed.

1. Primary characters

<Essential items>

Width of leaf (cm)

Width of the longest leaf is measured before flower bud differentiation, and classified into 3: small (<6.5cm), 5: intermediate (6.5~6.9cm), 7: broad (≥7.0cm).

Density of spines (spine number/cm)

Density of spines is expressed by the ratio of the total number of spines to the length of the longest leaf, and classified into 0: absent (0), 3: low (0.1~1.0/cm), 5: intermediate (1.1~2.0/cm), 7: high (>2.0/cm).

Number of slips

Number of slips is counted on plants with bud emergence, and classified into 3: few (<1.0), 5: intermediate (1.0~4.9), 7: many (≥5.0).

Size of fruit

Weight of mature fruit is measured at harvest, and size of fruit is classified into 3: small (weight<1kg), 5: intermediate (1~1.4kg), 7: large (≥1.5kg).

Index of fruit shape

Index of fruit shape is expressed by the ratio of length to the diameter of mature fruit, and classified into 3: small (<1.3), 5: intermediate (1.3), 7: large (≥1.4).

Number of fruitlets

Number of fruitlets per mature fruit is counted at harvest, and classified into 3: few (<80), 5: intermediate (80~99), 7: many (≥100).

Color of flesh

Color of flesh of mature fruit is observed at harvest, and classified into 1: white, 4: light yellow, 5: yellow, 6: dark yellow, 9: red.

<Optional items>

Plant form

Plant form is expressed by the angle of expanding leaves, and classified into 3: slanting, 5: intermediate, 7: expanding.

Shape of fruit

Shape of fruit is observed at harvest, and classified into 1: globular, 3: conical, 5: cylindrical, 7: inverse conical (Fig. 2).

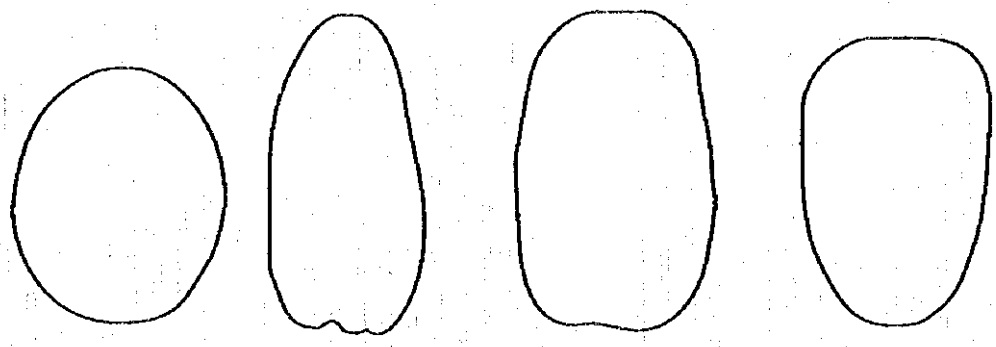

Fig. 2 Shape of fruits.

Skin color of mature fruit

Skin color of mature fruit is observed at harvest, and classified into 2: light yellow, 3: yellow, 4: yellow-orange, 5: orange, 6: orange-red, 7: red

Degree of projection of fruitlet

Degree of projection of fruitlet of mature fruit is observed at harvest, and classified into 3: concave, 5: flat, 7: convex (Fig. 3).

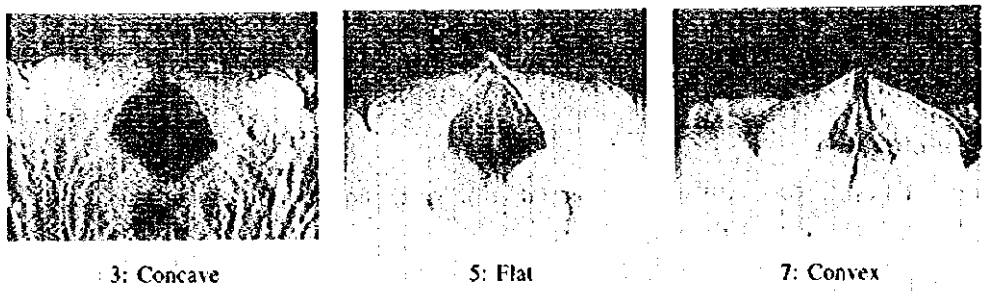

Fig. 3 Degree of projection of fruitlets.

Size of fruitlet

Size of fruitlet is expressed by the total weight of fruitlets per fruit / number of fruitlets per fruit, and classified into 3: small (weight <12g), 5: intermediate (12~14g), 7: large (≥15g).

Number of knobs

Number of knobs per fruit is counted at harvest, and classified into 3: few (<1.0), 5: intermediate (1.0~1.9), 7: many (≥2.0).

Number of buds with knobs

Number of buds with knobs per fruit is counted at harvest, and classified into 3: few (<1.0), 5: intermediate (1.0~1.9), 7: many (≥2.0) (Fig. 4 & Fig. 5).

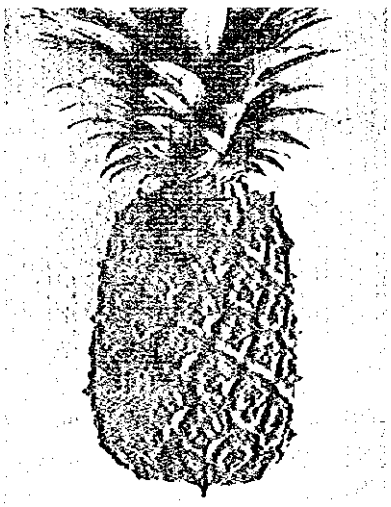

Fig. 4 Normal fruit.

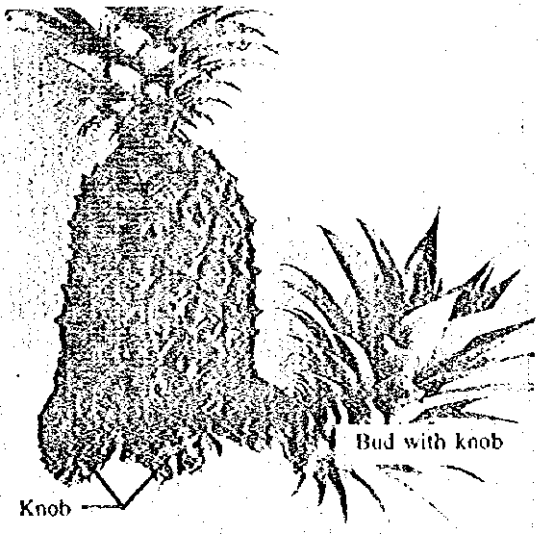

Fig. 5 Fruit with knobs and bud with knob.

Thickness of skin (cm)

Thickness of skin of mature fruit is measured at harvest as shown in Fig. 6, and classified into 3: thin (<0.7cm), 5: intermediate (0.7~1.3cm), 7: thick (≥1.4).

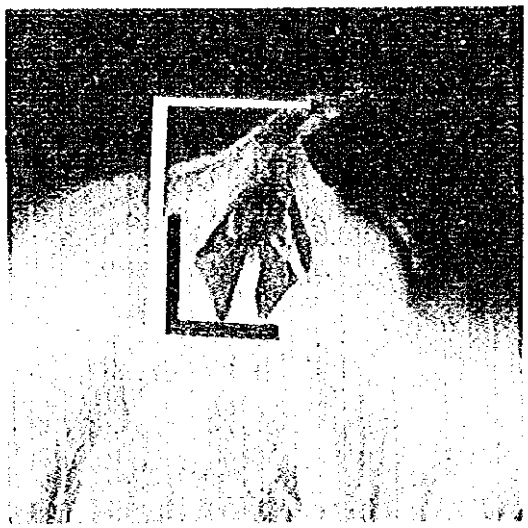

Fig. 6 Thickness of skin.

Thickness of flesh (cm)

Thickness of flesh is expressed by the distance from the bottom of the pistil to the core at harvest, and classified into 3: thin (<3.0cm), 5: intermediate (3.0~4.9cm), 7: thick (≥5.0cm).

Specific gravity of fruit

Based on the weight of fruit in water, the specific gravity of fruit is calculated, and classified into 3: light (<1.00), 5: intermediate (1.00~1.09), 7: heavy (≥1.10).

Diameter of core (cm)

Diameter of core of mature fruit is measured at harvest, and classified into 3: small (<2.0cm), 5: intermediate (2.0~2.9cm), 7: large (≥3.0cm).

Number of seeds

Number of seeds (including seeds in ovary) per fruitlet is counted at harvest, and classified into 0: no seeds (0), 3: few (0.1~2.0), 5: intermediate (2.1~5.0), 7: many (≥5.0).

Bud emergence time

The day when buds emerged in 50% of all the plants corresponds to the time of bud emergence, and classified into 3: early, 5: intermediate, 7: late.

Flowering time

The day when 50% of all the plants starts flowering corresponds to the flowering time, and classified into 3: early, 5: intermediate, 7: late.

Harvest time

The day when 50% of all the plants become mature corresponds to harvest time, and classified into 3: early, 5: intermediate, 7: late.

Days from bud emergence to harvest (days)

The duration of the period from bud emergence to harvest is classified into 3: short (<150 days), 5: intermediate (150~189 days), 7: long (≥190 days).

2. Secondary characters

<Essential Items>

Lodging resistance

Lodging resistance of pineapple plants or peduncles is evaluated under strong wind conditions, and classified into 3: low, 5: intermediate, 7: high.

Drought resistance

Drought resistance of pineapple plants is evaluated under dry conditions, and classified into 3: low, 5: intermediate, 7: high.

<Optional Items>

Degree of sunburn

Degree of sunburn of fruit surface is determined based on the following index: index of sunburn = [number of plants with respective sunburn degree × value of sunburn degree (0~100 points) / total number of plants examined] ×100, and classified into 3: low (<10), 5: intermediate (10~19), 7: high (≥20).

Crevice on fruit surface

Degree of crevice on fruit surface is determined based on the following index: index of crevice = [number of plants with respective degree of crevice on fruit surface × value of crevice degree (0~100) / total number of plants examined] ×100, and classified into 3: low (<10), 5: intermediate (10~19), 7: high (≥20).

3. Tertiary characters

<Essential items>

Sweetness of flesh juice (%)

Brix value of flesh juice of mature fruit is measured at harvest, and classified into 3: low (<12.5%), 5: moderate (12.5~14.4%), 7: high (≥14.5%).

Acidity of flesh juice (%)

Acidity of flesh juice of mature fruit is measured at harvest, and classified into 3: low (<0.6%), 5: moderate (0.6~0.9%), 7: high (≥1.0%).

Ratio of sweetness to acidity

Ratio of sweetness to acidity is expressed by the value of sweetness of flesh juice / acidity of flesh juice, and classified into 3: low (<20), 5: intermediate (20~24), 7: high (≥25).

<Optional items>

Quality of fresh fruit

Quality of fresh fruit is evaluated based on softness of flesh, volume of flesh juice, ratio of sweetness to acidity of flesh juice, and classified into 3: low, 5: intermediate, 7: high.

Flavor of flesh

Flavor of flesh is evaluated based on the smell, and classified into 0: absent, 3: weak, 5: intermediate, 7: strong.

Texture of flesh

Texture of flesh is determined by eating the fruit, and classified into 3: soft, 5: intermediate, 7: firm.

Moisture content of flesh (%)

Moisture content of flesh of mature fruit is measured at harvest, and classified into 3: low (<80%), 5: intermediate (80~89%), 7: high (≥90%).

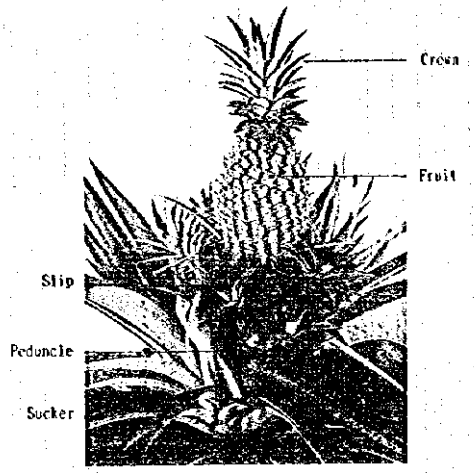

Photo.1 Pineapple plant.

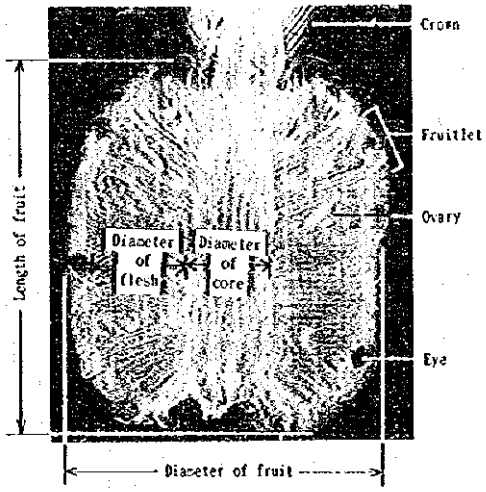

Photo. 2 Longitudinal section of pineapple fruit.

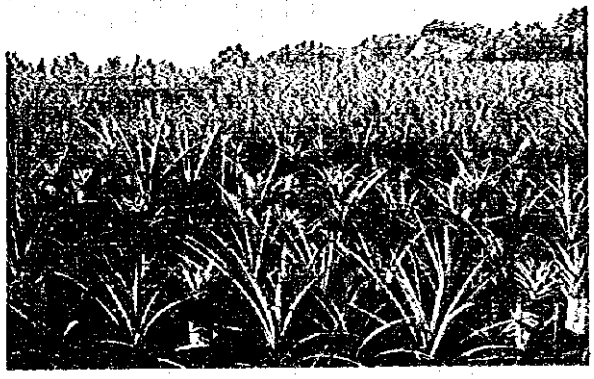

Photo. 3 Pineapple genetic resources in the evaluation field.